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MEDTAG: An Evaluation of Three Data Input Methods for Battlefield Medical Documentation

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Summary

Problem. During combat, documentation of medical treatment information is critical for maintaining continuity of patient care. However, knowledge of the prior status and treatment of patients is limited to the information noted on a paper Field Medical Card (FMC). MEDTAG, an electronic hand-held field medical documentation device, is designed to write and store an individual's medical data to a smart card (the Multi-technology Automated Reader Card [MARC]). The MEDTAG's two-button data entry method has been shown to document more information more quickly than the paper FMC. Recently, considerable interest in voice data entry methods has been shown. This interest in speech recognition technology for documenting battlefield medical care is motivated by the need to gather information quickly and accurately in an environment where the corpsman's eyes and hands are busy delivering medical care. It is hoped that this "multitasking" will maximize the time available for clinical care. While the technology for recognizing natural speech is advancing rapidly, a huge gap still exists between human speech recognized by the human ear and speech recognizable by a computer. Nevertheless, speech recognition technology has reached a level where, if applications are chosen appropriately, they can provide a means for communication between humans and computers, which, although not error-free, are approaching acceptable ranges. Research suggests that care must be taken when evaluating the utility of human-machine voice communication for new applications.

Objective. The objective of this study was to evaluate the speed and accuracy of three data entry methods (keyboard, two-button, and voice) for documenting casualty care. In addition, perceptions of corpsmen regarding the ease of learning and using these input methods were gathered.

Approach. For this study, a desktop computer was configured to simulate the operation of the MEDTAG. The MEDTAG software, developed by the Naval Health Research Center, was used. This MEDTAG simulator, called MEDSIM, was used as the platform for evaluating the speed and accuracy of entering medical treatment data using a standard keyboard, the two-button MEDTAG model, and a speech recognition system. To evaluate the speed and accuracy of medical treatment data entry, corpsmen were trained

and then instructed to document injury, treatment, patient condition, and disposition data for two hypothetical patients. Measurements of time and accuracy to enter these data were gathered for each input method. The experimental design was a one-way, repeated-measures design using the three methods of data entry as the variable of interest.

Results. Results showed that the MEDTAG two-button entry method for documenting casualty care was the fastest, followed by the keyboard and the voice data entry methods, respectively. The two-button method was 8% faster than voice data entry. Fewer content errors were made using the speech recognition method compared with the keyboard and the two-button, but the differences were not significant. Significantly fewer scrolling errors were made using the voice method than using the other two methods. In general, corpsmen reported that keyboard and speech were easiest to learn and to use for inputting data. They reported that the keyboard and the two-button method took less time compared with the FMC, and that mistakes were more likely to occur using the two-button method. When asked which method they would prefer to use, which would work best in combat, and which would most improve field medical care, they chose the two-button method most frequently. Finally, when asked which method allowed them freedom of their hands and interfered least with their duties, they chose the voice input method most frequently.

Discussion. In general, the speech recognition method was found to be slower, yet somewhat more accurate, than either the keyboard or the two-button method. Further, users reported a preference for the two-button method. These results must be viewed with the understanding that the subjects were novices with respect to voice input, but were very experienced with keyboard input. The novelty of the speech recognition system could account for these findings. Viewed in this light, voice holds much promise as a mode of input for medical documentation. Future work will focus on expanding the vocabulary available to the users for documentation, thus making the interaction more consistent with the way they actually perform their jobs.

Introduction

Historically, the Field Medical Card (FMC) has been used to provide the clinical documentation that moves with a casualty during evacuation. The Department of Defense (DoD) Medical Readiness Strategic Plan (MRSP), promulgated in February 1988, determined that the FMC was deficient, and a quad-service working group was formed to develop a revised card. Consensus among the services determined that the revised card captured all of the information needed at the first and second echelons of medical treatment, and that its format was an improvement over the original card. Field tests, however, revealed that the amount and accuracy of the information obtained with the revised card was significantly less than what was obtained with the original card (Wilcox & Pugh, 1990). This result underscored the need to evaluate empirically any modifications to medical data collection procedures.

Many of the deficiencies found in both the old and new field medical cards are inherent in any manual documentation procedure. For example, pens and pencils may become lost, reading and writing on paper at night is difficult or impossible, and handwriting is often illegible. As a result, the feasibility of using automated methods was studied. These studies led to the development of the MEDTAG concept (Galarneau & Wilcox, 1993a). The MEDTAG, an electronic, hand-held, two-button device was designed so that once activated, injury, treatment, patient conditions, and disposition data could be captured. An internal clock is used to time-date stamp all entries. Field tests using a proof-of-concept device demonstrated not only that the MEDTAG provided more accurate and complete information but that it also captured the data more quickly (Galarneau & Wilcox, 1993b).

To explore the potential of the MEDTAG concept, the Office of the Secretary of Defense (OASD, Health Affairs) requested that the original MEDTAG design be modified so that it would interface with the Multi-technology Automated Reader Card (MARC). The MARC, a "smart card," can store information such as name, social security number (SSN), blood type, and other critical information that could prove useful to emergency medical personnel. Thus the revised MEDTAG has the capability of recording treatment

information in battlefield situations, such as the type of injury, the type and time of administered medications, and MARC functions as a field data carrier that communicates medical information between facilities at the forward echelons of care. The results of MEDTAG/MARC field evaluations conducted by the 25th Infantry Division on Oahu, Hawaii, indicated that the concept may be capable of providing significant improvements to the battlefield medical treatment and documentation process (SRA, 1995).

Recent interest in new methods of data capture, such as speech recognition systems and biosensor technology, is motivated by the need to gather information quickly and accurately to maximize the time available for clinical care. Although the suggested modifications may meet these goals, research is needed to determine if the changes required for the MEDTAG concept will have the intended effect.

Speech Recognition Systems Defined. Schafer (1995) classified speech recognition systems according to the scope of their capabilities. Speaker-dependent systems must be "trained" to recognize the speech of an individual user, while speaker-independent systems attempt to cope with the variability of speech among speakers. Some systems recognize a large number of words or phrases, while simpler systems may recognize only a few words, such as the digits 0 through 9. Finally, it is easier to recognize isolated words than to recognize continuous free speech. Thus, a limited-vocabulary, isolated-word, speaker-dependent system would generally be the simplest to implement, while to approach the capabilities of the native speaker would require a large-vocabulary, continuous free speech, speaker-independent system. The accuracy of current speech recognition systems depends on the complexity of the operating conditions. Recognition error rates below 1% have been obtained for highly constrained vocabulary and controlled speaking conditions; but for large vocabulary, continuous free-speech systems, the word error rate may exceed 25 %.

Speech Recognition Applications. The largest ongoing commercial application of speech recognition systems is the automation of telephone operator services. The vocabularies have been expanded from "Yes" and "No" responses to include selection of paying choice (e.g., collect, bill to third party) and help commands, such as "operator." Other speech recognition applications include the automation of the operation of billing

functions, cellular voice dialers for autos (which promise the ultimate in safety, namely "eyes-free" and "hands-free" communication), voice routing of calls, automatic creation of medical reports, order entry (catalogue sales), forms entry (insurance, medical), and voice dictation (Rabiner, 1995). Despite the advance in technology, human factors research since the 1970s has provided no conclusive evidence that automatic speech recognition is superior to conventional input devices such as the keyboard and mouse, except in situations in which speech input is the only alternative (e.g., environments in which hands and eyes are busy).

Weinstein (1995) described several military and government applications of human-machine communication by voice. They include (1) speech recognition and synthesis for mobile command and control; (2) speech processing for a portable multifunction soldier's computer; (3) speech- and language-based technology for naval combat team tactical training; (4) speech technology for command and control on a carrier flight deck; (5) control of auxiliary systems, and alert and warning generation in fighter aircraft and helicopters; and (6) voice check-in, report entry, and communication for law enforcement agents or special forces. With respect to technological needs, military applications often place higher demand on robustness to acoustic noise and user stress than do civilian applications. However, military applications often can be carried out in constrained task domains, where, for example, the vocabulary and grammar for speech recognition can be limited.

Overview of Speech Recognition Literature. Cohen and Oviatt (1995) identified several situations in which spoken communication with machines may be advantageous, such as when:

- the user's hands or eyes are busy
- only a limited keyboard and/or screen is available
- pronunciation is the subject matter of computer use (translators)
- natural language interaction is preferred

They suggested that in many applications for which the user's input can be sufficiently constrained to permit high recognition accuracy, voice input leads to faster task performance and fewer errors than keyboard entry. Further, discrete word recognition applications have been successful when at least one of the following conditions exist:

speaker's hands are busy, mobility is required, speakers eyes are occupied, or harsh or cramped conditions preclude use of a keyboard.

Leggett and Williams (1984) conducted an experiment to assess the performance of speech input relative to keyboard input for computer program entry and editing tasks. The results showed that the subjects were able to complete more of the input and edit tasks by keyboard than by voice, but that keyboard input had a higher error rate than did voice input. These results should be interpreted with the understanding that the subjects were novices with respect to voice input. Martin (1989) compared speech with typed, full-word input, single key presses, and mouse clicks. Results supported the benefits of speech input over typed, full-word commands, and to a lesser extent, single key presses. Cochran, Riley, and Stuart (1980) showed speech input was slower but more accurate than typed input for entering interconnections in a circuit layout. Haller, Mutcschler, and Voss (1984) performed a study showing that voice input was slower and less accurate than keyboard input for positioning the cursor and correcting typing errors. Visick, Johnson, and Long (1984) compared speech and keyed input devices for entering the destinations in a parcel sorting task. When users' hands were busy at the sorting task, voice input was 37% faster but was less accurate than typed input. On the other hand, Nye (1982) reported that voice input could dramatically reduce error rates in airline baggage sorting tasks. Voice input of baggage destinations was performed with an error rate of 1% as opposed to an error rate of 10% to 40% for keyed input.

DeHaemer, Wright, and Dillon (1994) reported that data input by keyboard was significantly faster than input by speech for a spreadsheet task. However, for accuracy, efficiency, and user confidence, no significant difference was evident between keyboard and voice. They suggested that for most computer users and spreadsheet users, the best interface ultimately will be multimodal.

Taken as a whole, these studies are inconclusive. The quality (and cost) of the speech recognition technology used may be one factor responsible for the variable results. However, the advantages are clear of voice input over keyboard input for command activation (Poock, 1982), in applications for the handicapped (Damper, 1984), and in certain "hands busy/eyes busy" applications, such as package sorting and computer-aided

drafting. Speech is probably more efficient than typing in tasks involving short transactions and high interaction with the computer, and less efficient for tasks that require thinking time or long interactions (Chapanis, 1975; Martin, 1989). Studies performed more recently have focused on the utility of voice input as an additional input channel in multimodal interfaces. In addition to the successful application of voice to "hands busy" and "eyes busy" tasks, psychological research supports the view that people are more efficient in performing multiple tasks distributed across multiple response channels of differing modes (e.g., vocal and motor), since interference of tasks in the same modality decreases efficiency (Karl, Pettey, & Shneiderman, 1993; Wickens, Sandry, & Vidulich, 1983).

Problem

During combat, documentation of medical treatment information is critical for establishing and maintaining continuity of patient care. However, knowledge of the prior status and treatment of patients is limited to the information noted on a paper FMC. Although the MEDTAG's two-button data entry method has been shown to document more information more quickly than the FMC, there is considerable interest in voice data entry because a corpsman's eyes and hands are busy delivering medical care. Further, it is hoped that this "multitasking" will maximize the time available for casualty care. While the technology for recognizing natural speech is advancing rapidly, a gap remains between normal human speaking and the speech a computer is able to recognize. Nevertheless, speech recognition technology has reached a level where, if applications are chosen appropriately, they can provide a means for communication between computers and humans which although not error-free is approaching the acceptable range. Research suggests that care must be taken when evaluating the utility of human-machine voice communication for new applications. However, medical documentation on the battlefield appears to be a task that may take advantage of voice communication.

Objective

The objectives of this study were to evaluate three data entry methods for documenting casualty care and to obtain feedback from subjects regarding the methods. To evaluate the speed and accuracy of medical data entry, corpsmen were trained and then

instructed to document injury, treatment, patient condition, and disposition data for two hypothetical patients. Based on previous findings it was expected that the subjects would complete each scenario in less time and make fewer errors when using the voice input than when using the keyboard or the two-button methods. Further, it was expected that subjects would prefer voice input, that they would find using voice required less effort, was more comfortable, and was faster than the two-button or keyboard methods.

Method

Subjects. Twenty-four Navy corpsmen from the 1st Medical Battalion, Camp Pendleton, participated in this study. Their average age was 29 years and all had completed Field Medical Services School training. All corpsmen were high school graduates, with 15 of them having had some college experience. Seventy percent of them had been deployed at least once, and all reported having FMC experience. All but one of the corpsmen reported some, or daily, interaction with computers.

Materials. The MEDTAG software was created to allow the user to maneuver through a series of menus presenting items in an ordered fashion. Documentation with the current MEDTAG is achieved by depressing "Yes" or "No" buttons and thus moving through a series of menus using two buttons. The three injury scenarios used, a fragmentation wound, a burn wound, and a gunshot wound, are shown in Appendix A. The scenarios were chosen for variety and utilization of the MEDTAG menu items.

Equipment. For this study a desktop computer was configured to simulate MEDTAG operation. The software was designed to accept input from the keyboard, the two-button MEDTAG, and using voice. This MEDTAG simulator, called MEDSIM, was used as the platform for evaluating the speed and accuracy of entering medical treatment data using the keyboard, two-button MEDTAG model, and voice (see Figure 1). Although all three methods are shown in this figure, the participants used only one at a time. The following equipment was used: a Pentium-based desktop computer, a 16-inch color monitor with extended keyboard; a noise canceling head-mounted microphone; an ergonomic model of MEDTAG with functioning buttons; MARC cards; and a Datacard Series 50 Smart Card Reader/Writer.

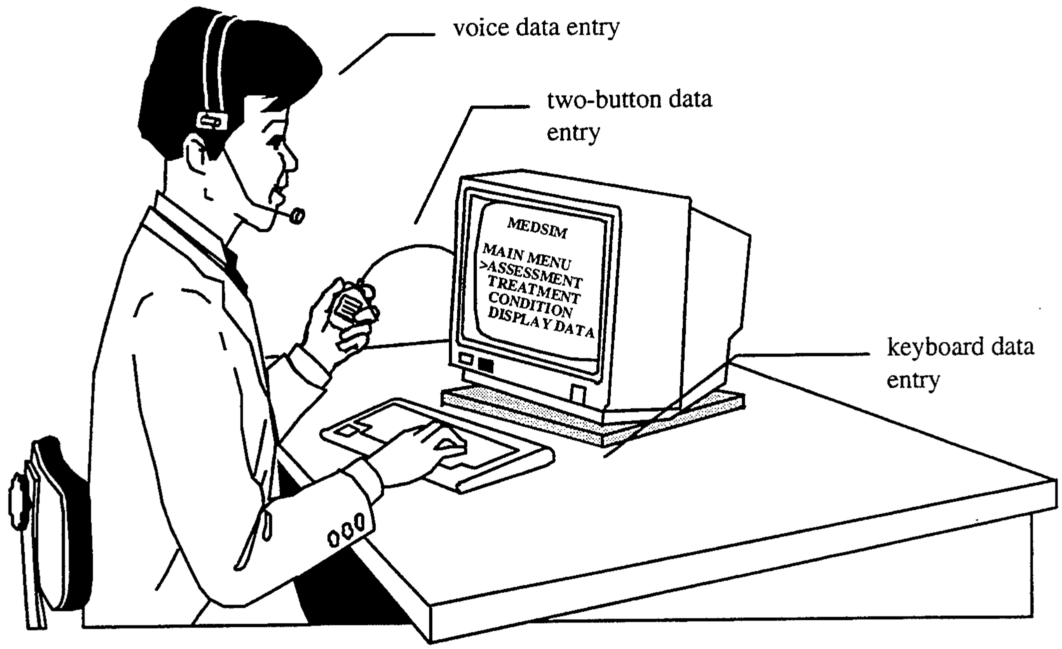

Figure 1. MEDSIM: The desktop computer configured to use keyboard, two-button, and speech data entry methods.

All three methods of data entry were connected to the computer. The data input methods used were:

> *Keyboard:* Only the "Y" and "N" keys from a standard desktop computer keyboard were used.
>
> *Two-button*: The two-button method of data entry was accomplished by using a small, hand-held MEDTAG model, which fits in one hand. The "No" button was pressed with the index finger and the "Yes" button with the thumb. Input was accomplished using the parallel port.
>
> *Speech recognition*: A speaker-adaptive, discrete word recognition system, developed with Voice Tools (Dragon Systems) was incorporated into the MEDSIM software. A lightweight, noise-canceling microphone and headset, Shure Sm10A, was positioned approximately 1/2 inch from the corner of the subject's mouth. To record data, the subject had to speak clearly ("Yes"/"No") into the microphone. As a part of training, a standard registration process for the user's voice was completed.

Care was taken to make the tasks for each type of input as operationally identical as possible. The systems provided auditory feedback in the form of a tone immediately after each key press, two-button press, or utterance was recognized.

Procedure. Each subject completed a demographic questionnaire. Training and testing took place in a quiet office environment. Subjects sat in front of the computer screen where they could see the MEDSIM software being presented. The subject trained the voice recognition system using the following words: one, two, three, four, five, six, seven, alpha, bravo, charlie, delta, echo, foxtrot, golf, yes, no, and quit. The word training process took about 2 min.

The training and testing instructions are included in Appendix B. The fragmentation wound scenario was used during training. The scenario was explained and a copy given to each subject. The subjects documented the condition and treatment information using all three methods of data input.

The subjects then documented two test scenarios, burn and gunshot wound, using each of the three input methods. The order of the three input methods was randomized. Measurements of time to enter these data and the accuracy of the data entered were gathered for each input method. The computer software automatically collected and recorded the time to document each scenario. System processing time and users response times, as well as user errors and recognition errors were collected. The computer recorded input accuracy. An observer recorded recognition errors.

Subjects also completed a questionnaire, shown in Appendix C, about their preferences and experiences with the three data input methods.

Results

Documentation Speed. The computer automatically gathered times taken to complete the gunshot wound and burn scenarios. Scenario completion time was adjusted for differences in system registration times for the three methods: 13 ms for the keyboard method, 157 ms for the two-button method, and 504 ms for the speech input method. Total time to document a scenario was adjusted using these registration times as constants. So, to the extent possible, an attempt was made to control for the

imperfections of today's technology and focus on the long-term utility of speech technology.

A repeated-measures analysis of variance, with data entry method as the within-subjects factor, was performed. The differences in the times required by the three data entry methods to completely document the combat injury scenarios were statistically signifcant, $F_{2,46} = 4.29$, $p < .02$. Simple effects tests revealed that the two-button method was significantly faster than the voice data entry method, $F_{1,46} = 8.53$, $p < .01$, while no significant differences were found between the two-button and keyboard, or the keyboard and voice input modes.

Table 1 presents the means and standard deviations for the documentation time for the three input methods. The average corrected times taken to complete documentation of the two test scenarios were 6 min 10 s using the two-button method, 6 min 24 s using the keyboard, and 6 min 40 s using the voice data input method. Documentation time using the two-button method was 34 s faster than for voice data entry.

Table 1

Means and Standard Deviations for Documentation Time

Using the Three Entry Methods

	Keyboard	Two-Button	Voice
Mean (in seconds)	384.73	369.84	403.69
Standard Deviation	56.42	65.01	70.63

Documentation Accuracy. Three kinds of errors denoting inaccuracy were monitored: content errors, universal errors, and method-specific errors.

Content Errors. Documentation that correctly reported casualty medical data according to the scenario was rated as accurate. Only data that were written to the MARC were used in this analysis. Documentation that was either inaccurately recorded or completely missing was rated as a content error. For example, if the scenario required the user to input the type of injury as a penetrating wound, any response other than that was

considered inaccurate. Another content error occurred when vital signs were bypassed and not entered when they should have been.

Universal Errors. Errors resulting from the software or hardware common to all three methods were considered universal errors. For example, the scroll error was a user error common to the three data entry methods. This occurred when the subject bypassed the intended item by recording too many "No" responses. Losing the place on the menu or becoming confused was also considered a universal error. Problems with the Datacard reader/writer or the MARC itself were considered hardware errors common to the three methods. The frequency of content and universal errors for each data entry method for the two test scenarios are presented in Table 2. A goodness of fit test for the content errors did not yield a significant chi-square. However, a significant chi-square was found for the universal errors, $X^2 = 9.52$, $p < .01$. Of the three types of universal errors that could be made, scroll errors accounted for 77% of the errors for the keyboard method, 77% for the two-button method, and 60% for the speech data input method.

Table 2

Frequency of Content and Universal Errors by Data Entry Method

	Content Errors	Universal Errors	Total
Keyboard	28	45	73
Two-Button	31	34	65
Speech	22	20	42
Total	81	99	180

Although the difference in the number of content errors made using the three methods was not significant, the impact of the errors should be examined further. An incorrect response could influence menu navigation in one of three ways: 1) it could effect that one screen only; 2) it could require the subject to respond to additional screens, or 3) it could allow the subject to skip several subsequent screens. Content errors that add or delete screens could increase or decrease the time required to document the injury, it is very difficult, however, to determine the exact amount of time these errors represent.

Method-Specific Errors. Errors occurring as a result of the individual data entry method are considered here. There were no keyboard errors and only four errors were due to the two-button method. There were 29 errors attributed to the speech recognition technology. These included speaking while the mike was off and speaking a word that the system did not recognize. Of the 5,928 utterances required by the task the voice recognition system failed to recognize only eight. This accounts for .135% used during the experiment. This type of error requires the user to restate the word. On the other hand, one misrecognition error occurred for the entire study. This type of error results in the unintended recording of information.

Perceptions of the Data Entry Methods. The subjects were asked to indicate their level of agreement with statements regarding each data entry method. For each data input method they were asked (1) how easy it was to learn, (2) whether it was easy to make mistakes using that method, (3) whether data entry with that method was faster than with the FMC, and (4) whether the method was uncomfortable or awkward. Means and standard deviations are shown in Table 3.

Table 3

Means and Standard Deviations for the Attitude Items Regarding the Data Entry Methods

Item		Keyboard	Two-Button	Speech
1. Method is easy to learn.	Mean	1.41	1.62	1.41
	SD	.58	.87	.58
2. Easy to input data using this method.	Mean	1.41	1.75	1.70
	SD	.58	.94	.85
3. Method takes less time than FMC.	Mean	1.75	2.00	2.15
	SD	.73	1.10	1.03
4. Easy to make mistakes with method.	Mean	3.41	2.86	3.00
	SD	1.05	.96	1.14
5. Takes longer to use than FMC.	Mean	3.75	3.71	3.41
	SD	1.03	1.04	1.28
6. Method is uncomfortable/awkward.	Mean	3.83	3.54	3.54
	SD	.86	.93	.83

Note. A 5-point scale was used. 1= Strongly Agree; 2= Agree; 3= Neutral; 4= Disagree; 5= Strongly Disagree.

In general, the corpsmen reported that keyboard and voice were easy to learn and to use for inputting data, that the keyboard and the two-button methods took less time compared with the FMC, and that it was easy to make mistakes using the two-button method. In addition, the corpsmen reported that they felt comfortable speaking to the computer and that the microphone was comfortable. The corpsmen also reported that they thought paper copies of medical records were very important, and that they were satisfied with the "Yes"/"No" format of the input screens.

Table 4 presents the responses to the forced-choice items.

Table 4
Responses to the Forced-Choice Attitude Items

Item	FMC n (%)	Keyboard n (%)	Two-Button n (%)	Speech n (%)
1. Overall, which do you like best?	0 (0)	8 (33)	11 (46)	5 (21)
2. Overall, which do you like least?	9 (37)	3 (12)	4 (17)	8 (33)
3. Which do you think is the fastest?	0 (0)	11 (46)	8 (33)	4 (17)
4. Which do you think is the slowest?	10 (42)	0 (0)	3 (12)	11 (46)
5. Which do you think collects the most accurate information?	0 (0)	13 (54)	6 (25)	4 (17)
6. With which do you think you make the most mistakes?	5 (21)	7 (29)	3 (12)	7 (29)
7. Which would you prefer to use?	0 (0)	5 (21)	11 (46)	6 (25)
8. Which would work best in combat?	0 (0)	0 (0)	19 (79)	4 (17)
9. Which would improve field medical care the most?	0 (0)	1 (4)	14 (58)	8 (33)
10. Which would be the least intrusive?	2 (8)	3 (12)	9 (37)	7 (29)
11. Which would give your hands the most freedom?	1 (4)	0 (0)	1 (4)	20 (83)
12. Which would interfere least with your duties?	0 (0)	0 (0)	4 (17)	17 (71)

When asked which method they liked best almost half (46%) of the corpsmen chose the two-button method, and when asked which they liked least 70% chose either the FMC or the voice input. The corpsmen reported that the keyboard or the two-button method were the fastest, and the FMC and voice were the slowest. They also reported that they thought the most accurate information was collected using the keyboard method. When asked which method they would prefer to use, which would work best in combat, and which would most improve field medical care, the two-button method was chosen most often. Further, the voice input method was most frequently chosen when asked which method would give them the most hand freedom and which would interfere least with their duties.

Table 5 shows the responses when the corpsmen were asked to choose the best combination of methods. The two-button method was the most frequently mentioned in some combination. Not reflected in the table were the 3 corpsmen who reported that keyboard, two-button, and speech would be the best combination, and the one who reported that two-button alone was best.

Table 5

Preferred Combination of Data Entry Methods

	FMC	Keyboard	Two-Button	Speech
FMC	----	1	8	0
Keyboard		----	5	1
Two-Button			----	5
Speech				----

Discussion

Designing an effective user interface for a voice application involves consideration of (1) the information requirements of the task; (2) the limitations and capabilities of the voice technology, and (3) the expectations, expertise, and preferences of the user (Kamm, 1995). In general, speech recognition was found to be slower, yet

somewhat more accurate, than either the keyboard or the two-button method, and users reported a preference for the two-button method.

MEDSIM, the PC-based simulator and software, performed extremely well in this study. The equipment, card reader, two-button interface, and speech recognition technology systems all performed better than had been anticipated. The speech recognition rate was extremely high (99.99%), partly as a function of the highly constrained vocabulary and controlled speaking conditions. Although the vocabulary for the speech recognition was limited, the system was robust enough to handle external environmental noise (e.g., lawnmowers, other voices).

The finding that the two-button and keyboard data input methods were faster than the speech method could be attributed in part to the novelty of the speech recognition system. Although training using the voice method was provided, the technology was new to the users. The 34 s advantage of the keyboard method may not appear significant, however, it could be very critical in the context of combat casualty care. The speech recognition method did, however, produce fewer errors overall. The novelty of the method may not only have slowed the users down, it also may have made them more cautious. This could explain the significantly fewer scroll errors made using the speech technology compared with both the keyboard and two-button methods. In general, the corpsmen preferred the two-button method over the keyboard and voice input methods. However, the participants expressed the desirability of having speech input as an option for medical documentation.

These findings are partially consistent with DeHaemer et al. (1994) who found that data input by keyboard was significantly faster than by speech. For accuracy, keystroke, efficiency, and user confidence, they found no significant differences between keyboard and voice input. They suggested the best interface will ultimately be multimodal. This would take advantage of the combination of voice, keyboard, and touchscreen input to suit the task and the user. In addition to the successful application of voice to "hands busy" and "eyes busy" tasks, psychological research supports the view that people are more efficient in performing multiple tasks distributed across multiple response channels of differing modalities (e.g., vocal and motor), since interference of

multiple tasks performed in the same modality decreases efficiency (Chapanis, 1975; Martin, 1989; Wickens, Sandry, & Vidulich, 1983). Building good speech recognition systems should enhance user-computer interaction because, in multi-task situations, it provides an additional response channel over which the workload can be spread.

This study also suggests that speech input capabilities may change the nature of what information users enter into the system. Although use of speech input capability was *not* successful in this study, it may become more useful when users are allowed to enter the name of the injury, the type of treatment, and the condition of the patient. Modifying the task to more closely resemble the job performed has been shown in other studies to improve the speed and accuracy of the voice input method (Kamm, 1995).

A gap exists between performance in the lab and performance in the field, however. Problems not encountered in the lab but very likely to be found in the field might include variation in speaking style, noise, ambiguity of language, or confusion on the part of the speaker. Therefore, applied evaluations of speech input devices are an important source of information. They may support the claim that one value of speech input devices lies in freeing users from the keyboard, enabling them to use their hands for one aspect of a task and their voices for another. With respect to technological needs, military applications often place higher demand for robustness in the presence of acoustic noise and user stress than do civilian applications. But military applications often can be carried out in constrained task domains, where, for example, the vocabulary and grammar for speech recognition can be limited.

The voice communication interface, which is critical to user acceptance of voice processing technology, also needs to be examined. Interface issues that need to be considered include vocabulary size and content, continuous speech versus isolated words, constraints on grammar and speaking style, the need for training of the recognition system, the quality and naturalness of synthetic voice response, the way the system handles its errors in speech understanding, and the availability and convenience of alternate communication modalities. Voice in combination with full screen/keyboard entry would allow the user to jump to specific sections of the software. This could be beneficial for time-constrained situations when only essential information can be gathered and

transferred. Future studies will explore the impact of vocabulary size and content, as well as the effect of alternate communication modalities on the speed and accuracy of medical documentation.

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Appendix A

Injury Scenarios

MEDTAG Scenario - #1 (FRAG)

INJURY: FRAG - LEFT LEG AMPUTATION - RIGHT KNEE
TREATMENT: BATTLE DRESS TOUR. W/ PRESS
PAT. COND.: CONSCIOUS
DISPOSITION: MEDEVAC

Begin: Insert Card

1
ALLERGIC
PENICILLIN

IS PROBLEM A RESULT OF HOSTILE ACTION?

PRESS 'NO' OR 'YES'

2
SMITH
JOHN
D
BLOOD TYPE: O+

WAS PATIENT TREATED FOR SHOCK?

PRESS 'NO' OR 'YES'

3
PROBLEM
>BATTLE INJURY
NON-BATTLE INJURY
DISEASE
SICK CALL
OTHER

'NO' MOVES ARROW
'YES' SELECTS ITEM

4
DO YOU WANT TO BYPASS VITALS?

PRESS 'NO' OR 'YES'

5
PULSE RATE
UNKNOWN
NO PULSE
1-19/MIN PULSE
20-39/MIN PULSE
40-59/MIN PULSE
60-79/MIN PULSE
80-99/MIN PULSE
>100+/MIN PULSE

6
PULSE STRENGTH
UNKNOWN
NO PULSE
WEAK PULSE
>MODERATE PULSE
STRONG PULSE

7
RESPIRATION
UNKNOWN
NO RESPIRATION
1-5/MIN RESP
6-9/MIN RESP
10-19/MIN RESP
>20-29/MIN RESP
30+/MIN RESP

8
RESPIRATION QUALITY
UNKNOWN
ABSENT RESP
NORMAL RESP
>SHALLOW RESP
LABORED RESP
DISTRESSED RESP
IRREGULAR RESP

9
SYSTOLIC BP
UNKNOWN
NO SBP
1-49 SBP
50-75 SBP
76-89 SBP
>90-109 SBP
110-129 SBP
130-149 SBP
150+ SBP

10
DIASTOLIC BP
UNKNOWN
NO DBP
1-19 DBP
20-39 DBP
40-59 DBP
>60-79 DBP
80-99 DBP
100-119 DBP
120+ DBP

11
BLEEDING LEVEL
UNKNOWN
NO BLOOD LOSS
>MILD BLOOD LOSS
MODERATE BLD LOSS
SEVERE BLOOD LOSS

12
CONSCIOUSNESS
UNKNOWN
ALERT
>RESPONDS TO VOICE
RESPONDS TO PAIN
UNRESPONSIVE

13
MEDICATIONS
NONE/NO MORE
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
>IV
ANTIBIOTICS
MISC MEDICATIONS

14
IV
>RINGERS LACTATE
SALINE
D5W
BLOOD PRODUCT
OTHER IV

15
IV VOLUME
UNKNOWN
LESS THAN 500 cc
500 cc
>1000 cc
1500 cc
2000 cc
2500 cc
3000 cc
MORE THAN 3000 cc

16
GAUGE OF NEEDLE
UNKNOWN
12 GAUGE NEEDLE
14 GAUGE NEEDLE
>16 GAUGE NEEDLE
18 GAUGE NEEDLE
OTHER GAUGE

17
IV SITE
>ARM IV SITE
HAND IV SITE
LEG IV SITE
FOOT IV SITE
NECK IV SITE
OTHER IV SITE

18
WHICH SIDE?

>RIGHT SIDE
LEFT SIDE
BOTH SIDES

Continue to next page ->

Continue

19

YOU ARE SELECTING:

RINGERS LACTATE
1000 CC
16 GAUGE NEEDLE
ARM IV SITE
RIGHT SIDE

IS THIS CORRECT?

PRESS 'NO' OR 'YES'

20

MEDICATIONS
NONE/NO MORE
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
IV
>ANTIBIOTICS
MISC MEDICATIONS

21

ANTIBIOTICS
>ORAL ANTIBIOTICS
INJECTED ANTIBIOT
TOPICAL ANTIBIOT

22

YOU ARE SELECTING:
ORAL ANTIBIOTICS

IS THIS CORRECT?

PRESS 'NO' OR 'YES'

23

MEDICATIONS
>NONE/NO MORE MEDS
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
IV
ANTIBIOTICS
MISC MEDICATIONS

24

DRESSINGS
NONE/NO MORE
>BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
OTHER DRESSING

25

DRESSINGS
>NONE/NO MORE
BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
OTHER DRESSING

26

APPLICATIONS
NONE/NO MORE
>TOURNIQUET
ICE/COLD PACK
HEAT PACK
DECON WIPE
IMMOBILIZE OBJECT
OINTMENT/GEL
SALINE DRESSING
OTHER APPLICATION

27

APPLICATIONS
>NONE/NO MORE
TOURNIQUET
ICE/COLD PACK
HEAT PACK
DECON WIPE
IMMOBILIZE OBJECT
OINTMENT/GEL
SALINE DRESSING
OTHER APPLICATION

28

GENERAL PROCEDURES
>NONE/NO MORE
ASSIST VENTILATION
CRICOTHYROIDOTOMY
NEEDLE THORACENT
CPR
ON AFFECTED SIDE
CLEAN/FLUSH WOUND
C-SPINE/BOARD
INDUCED VOMITING
SALVAGED BODY PART

29

ACTION TAKEN
RETURNED TO DUTY
AMBULATORY EVAC
>MEDEVAC
EXPIRED

30

MEDICAL PROVIDER
>CORPSMAN/MEDIC
SELF-AID
BUDDY-AID
DOCTOR
NURSE
OTHER MED PROVIDER

31

MAIN MENU
>ASSESSMENT
TREATMENT
PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

32

ASSESSMENT
>WOUND
ENVIRONMENTAL
DISEASE/INFECTION
BURN
INTERNAL
BEHAVIORAL/PSYCH
MISC PROBLEMS
UNKNOWN PROBLEM
EXIT

33

WOUND TYPE
>PENETRATING
LACERATION
ABRASION
MUSCLE/SKELETAL
BITE/STING
SUPERFICIAL
OTHER WOUND TYPE
EXIT

34

PENETRATING WOUND
GUNSHOT
>FRAGMENTATION
EVISCERATION
STAB WOUND
PUNCTURE WOUND
IMPALED OBJECT
PERFORATION
OTHER PENETRATING
EXIT

35

LOCATION
NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
>LEG/FOOT

36

LEG/FOOT LOCATION
FULL LEG
>UPPER LEG
KNEE
SHIN
CALF
ANKLE
FOOT
TOE
EXIT

Continue to next page ->

Continue

37
WHICH AREA?
NO MORE
RIGHT
>LEFT
BACK
FRONT
TOP
CENTER
BOTTOM

38
WHICH AREA?
>NO MORE
RIGHT
LEFT
BACK
FRONT
TOP
CENTER
BOTTOM

39
LOCATION
>NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

40
MAIN MENU
>ASSESSMENT
TREATMENT
PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

41
ASSESSMENT
>WOUND
ENVIRONMENTAL
DISEASE/INFECTION
BURN
INTERNAL
BEHAVIORAL/PSYCH
MISC PROBLEMS
UNKNOWN PROBLEM
EXIT

42
WOUND TYPE
PENETRATING
LACERATION
ABRASION
>MUSCLE/SKELETAL
BITE/STING
SUPERFICIAL
OTHER WOUND TYPE
EXIT

43
MUSCLE/SKELETAL
CRUSHING WOUND
FRACTURE
DISLOCATION
>AMPUTATION
AVULSION
SPRAIN/STRAIN
OTHER M/S WOUND
EXIT

44
LOCATION
NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
>LEG/FOOT

45
LEG/FOOT LOCATION
FULL LEG
UPPER LEG
>KNEE
SHIN
CALF
ANKLE
FOOT
TOE
EXIT

46
WHICH AREA?
NO MORE
>RIGHT
LEFT
BACK
FRONT
TOP
CENTER
BOTTOM

47
WHICH AREA?
>NO MORE
RIGHT
LEFT
BACK
FRONT
TOP
CENTER
BOTTOM

48
LOCATION
>NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

49
MAIN MENU
ASSESSMENT
> TREATMENT
PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

50
TREATMENT
DRESSINGS
APPLICATIONS
>PROCEDURES
MEDICATIONS
OTHER TREATMENT
EXIT

51
PROCEDURES
NONE/NO MORE
AIRWAY/BREATHING
>STANDARD PROCEDS
IMMOBILIZE PATIENT
MISC PROCEDURES

52
STANDARD PROCEDURES
TREATED FOR SHOCK
C P R
ADMIN OXYGEN
CHEST TUBE
>ELEVATED EXTREMITY
ELEVATED HEAD
ON AFFECTED SIDE
CLEAN/FLUSH WOUND
EXIT

53
PROCEDURES
NONE/NO MORE
AIRWAY/BREATHING
STANDARD PROCEDS
>IMMOBILIZE PATIENT
MISC PROCEDURES

54
IMMOBILIZE PATIENT
C-SPINE/BOARD
C-COLLAR
>SPLINT
WRAP/BANDAGE
SLING
OTHER IMMOBILIZE
EXIT

Continue to next page ->

Continue

55

PROCEDURES
>NONE/NO MORE
AIRWAY/BREATHING
STANDARD PROCEDS
IMMOBILIZE PATIENT
MISC PROCEDURES

56

MAIN MENU
ASSESSMENT
TREATMENT
>PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

57

PATIENT CONDITIONS
VITALS
BLOOD LOSS
CHEST CONDITIONS
LUNG SOUNDS
>CONSCIOUSNESS
SKIN CONDITIONS
EYE CONDITIONS
SYMPTOMS
GLASGOW
EXIT

58

CONSCIOUSNESS
UNKNOWN
ALERT
RESPONDS TO VOICE
>RESPONDS TO PAIN
UNRESPONSIVE

END: Please exit the program.

MEDTAG Scenario - #2 (GSW)

INJURY: GSW-LEFT SHOULDER
TREATMENT: BATTLE DRESS
PAT. COND.: RESPONDS TOPAIN
LABORED BREATHING
DISPOSITION: MEDEVAC

Begin: Insert Card

1

ALLERGIC TO
PENICILLIN

IS PROBLEM A RESULT
OF HOSTILE ACTION?

PRESS 'NO' OR **'YES'**

2

SMITH
JOHN
D
BLOOD TYPE: O+

WAS PATIENT
TREATED FOR SHOCK?

PRESS **'NO'** OR 'YES'

3

PROBLEM
>BATTLE INJURY
NON-BATTLE INJURY
DISEASE
SICK CALL
OTHER

'NO' MOVES ARROW
'YES' SELECTS ITEM

4

DO YOU WANT TO
BYPASS VITALS?

PRESS **'NO'** OR 'YES'

5

PULSE RATE
UNKNOWN
NO PULSE
1-19/MIN PULSE
20-39/MIN PULSE
>40-59/MIN PULSE
60-79/MIN PULSE
80-99/MIN PULSE
100+/MIN PULSE

6

PULSE STRENGTH
UNKNOWN
NO PULSE
>WEAK PULSE
MODERATE PULSE
STRONG PULSE

7

RESPIRATION
UNKNOWN
NO RESPIRATION
1-5/MIN RESP
>6-9/MIN RESP
10-19/MIN RESP
20-29/MIN RESP
30+/MIN RESP

8

RESPIRATION QUALITY
UNKNOWN
ABSENT RESP
NORMAL RESP
SHALLOW RESP
>LABORED RESP
DISTRESSED RESP
IRREGULAR RESP

9

SYSTOLIC BP
UNKNOWN
NO SBP
1-49 SBP
50-75 SBP
>76-89 SBP
90-109 SBP
110-129 SBP
130-149 SBP
150+ SBP

10

DIASTOLIC BP
>UNKNOWN
NO DBP
1-19 DBP
20-39 DBP
40-59 DBP
60-79 DBP
80-99 DBP
100-119 DBP
120+ DBP

11

BLEEDING LEVEL
UNKNOWN
NO BLOOD LOSS
MILD BLOOD LOSS
>MODERATE BLD LOSS
SEVERE BLOOD LOSS

12

CONSCIOUSNESS LEVEL
UNKNOWN
ALERT
RESPONDS TO VOICE
>RESPONDS TO PAIN
UNRESPONSIVE

13

MEDICATIONS
NONE/NO MORE MEDS
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
>IV
ANTIBIOTICS
MISC MEDICATIONS

14

IV
>RINGERS LACTATE
SALINE
D5W
BLOOD PRODUCT
OTHER IV

15

IV VOLUME

UNKNOWN
LESS THAN 500 cc
500 cc
>1000 cc
1500 cc
2000 cc
2500 cc
3000 cc
MORE THAN 3000 cc

16

GAUGE OF NEEDLE

UNKNOWN
12 GAUGE NEEDLE
14 GAUGE NEEDLE
>16 GAUGE NEEDLE
18 GAUGE NEEDLE
OTHER GAUGE

17

IV SITE
>ARM IV SITE
HAND IV SITE
LEG IV SITE
FOOT IV SITE
NECK IV SITE
OTHER IV SITE

18

WHICH SIDE?

>RIGHT SIDE
LEFT SIDE
BOTH SIDES

Continue to next page ->

Continue

19

YOU ARE SELECTING:

RINGERS LACTATE
1000 CC
16 GAUGE NEEDLE
ARM IV SITE
RIGHT SIDE

IS THIS CORRECT?

PRESS 'NO' OR 'YES'

20

MEDICATIONS
>NONE/NO MORE MEDS
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
IV
ANTIBIOTICS
MISC MEDICATIONS

21

DRESSINGS
NONE/NO MORE
>BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
OTHER DRESSING

22

DRESSINGS
>NONE/NO MORE
BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
OTHER DRESSING

23

APPLICATIONS
>NONE/NO MORE
TOURNIQUET
ICE/COLD PACK
HEAT PACK
DECON WIPE
IMMOBILIZE OBJECT
OINTMENT/GEL
SALINE DRESSING
OTHER APPLICATION

24

GENERAL PROCEDURES
>NONE/NO MORE
ASSIST VENTILATION
CRICOTHYROIDOTOMY
NEEDLE THORACENT
CPR
ON AFFECTED SIDE
CLEAN/FLUSH WOUND
C-SPINE/BOARD
INDUCED VOMITING
SALVAGED BODY PART

25

ACTION TAKEN
RETURNED TO DUTY
AMBULATORY EVAC
>MEDEVAC
EXPIRED

26

MEDICAL PROVIDER
>CORPSMAN/MEDIC
SELF-AID
BUDDY-AID
DOCTOR
NURSE
OTHER MED PROVIDER

27

MAIN MENU
>ASSESSMENT
TREATMENT
PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

28

ASSESSMENT
>WOUND
ENVIRONMENTAL
DISEASE/INFECTION
BURN
INTERNAL
BEHAVIORAL/PSYCH
MISC PROBLEMS
UNKNOWN PROBLEM
EXIT

29

WOUND TYPE
>PENETRATING
LACERATION
ABRASION
MUSCLE/SKELETAL
BITE/STING
SUPERFICIAL
OTHER WOUND TYPE
EXIT

30

PENETRATING WOUND
>GUNSHOT WOUND
FRAGMENTATION
EVISCERATION
STAB WOUND
PUNCTURE WOUND
IMPALED OBJECT
PERFORATION
OTHER PENETRATING
EXIT

31

EXIT WOUND?

PRESS '<u>NO</u>' OR 'YES'

32

LOCATION
NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
>UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

33

UPPER TORSO
>SHOULDER
CHEST
UPPER BACK
UPPER SPINE
RIBS
ABDOMEN
EXIT

34

WHICH SIDE?

RIGHT SIDE
>LEFT SIDE
BOTH SIDES

35

LOCATION
>NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

36

MAIN MENU
ASSESSMENT
TREATMENT
>PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

Continue to next page ->

37

PATIENT CONDITIONS
 VITALS
 BLOOD LOSS
 CHEST CONDITIONS
 LUNG SOUNDS
 CONSCIOUSNESS
 SKIN CONDITIONS
 EYE CONDITIONS
 SYMPTOMS
>GLASGOW
 EXIT

38

EYE OPEN RESPONSE
 UNKNOWN
 SPONTANEOUS EYE
>EYE OPEN TO VOICE
 EYE OPEN TO PAIN
 NO EYE OPENING

39

VERBAL RESPONSE
 UNKNOWN
>ORIENTED
 CONFUSED
 INAPPROPRIATE
 INCOMPREHENSIBLE
 NO VERBAL RESPONSE

40

MOTOR RESPONSE
 UNKNOWN
>OBEYS COMMANDS
 LOCAL RESPONSE
 WITHDRAWS TO PAIN
 FLEXION TO PAIN
 EXTENSION TO PAIN
 NO MOTOR RESPONSE

41

MAIN MENU
 ASSESSMENT
 TREATMENT
 PATIENT CONDITION
 DISPOSITION
 DISPLAY PATIENT ID
 DISPLAY MED-ALERT
>DISPLAY MED DATA
 FMDS

END: Please exit the program.

MEDTAG Scenario - #3 (BURN)

INJURY: BURN - THERMAL
FULL-THICKNESS
CHEST
TREATMENT: IV, DRESSING
PAT. COND.: RESPONDS TO PAIN
DISPOSITION: MEDEVAC

Begin: Insert Card

1

ALLERGIC
PENICILLIN

IS PROBLEM A RESULT
OF HOSTILE ACTION?

PRESS 'NO' OR **'YES'**

2

SMITH
JOHN
D
BLOOD TYPE: O+

WAS PATIENT
TREATED FOR SHOCK?

PRESS 'NO' OR **'YES'**

3

PROBLEM
>BATTLE INJURY
NON-BATTLE INJURY
DISEASE
SICK CALL
OTHER

'NO' MOVES ARROW
'YES' SELECTS ITEM

4

DO YOU WANT TO
BYPASS VITALS?

PRESS 'NO' OR **'YES'**

5

BLEEDING LEVEL
UNKNOWN
>NO BLOOD LOSS
MILD BLOOD LOSS
MODERATE BLD LOSS
SEVERE BLOOD LOSS

6

CONSCIOUSNESS
UNKNOWN
ALERT
RESPONDS TO VOICE
>RESPONDS TO PAIN
UNRESPONSIVE

7

MEDICATIONS
NONE/NO MORE MEDS
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
>IV
ANTIBIOTICS
MISC MEDICATIONS

8

IV
>RINGERS LACTATE
SALINE
D5W
BLOOD PRODUCT
OTHER IV

9

IV VOLUME

UNKNOWN
LESS THAN 500 cc
500 cc
>1000 cc
1500 cc
2000 cc
2500 cc
3000 cc
MORE THAN 3000 cc

10

GAUGE OF NEEDLE
UNKNOWN
12 GAUGE NEEDLE
14 GAUGE NEEDLE
>16 GAUGE NEEDLE
18 GAUGE NEEDLE
OTHER GAUGE

11

IV SITE
>ARM IV SITE
HAND IV SITE
LEG IV SITE
FOOT IV SITE
NECK IV SITE
OTHER IV SITE

12

WHICH SIDE?

>RIGHT SIDE
LEFT SIDE
BOTH SIDES

13

YOU ARE SELECTING:

RINGERS LACTATE
1000 CC
16 GAUGE NEEDLE
ARM IV SITE
RIGHT SIDE

IS THIS CORRECT?

PRESS 'NO' OR 'YES'

14

MEDICATIONS
>NONE/NO MORE MEDS
ASPIRIN
ATROPINE
TWO PAM CHLORIDE
MORPHINE
DIAZEPAM
IV
ANTIBIOTICS
MISC MEDICATIONS

15

DRESSINGS
NONE/NO MORE
BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
>OTHER DRESSING

16

DRESSINGS
>NONE/NO MORE
BATTLE DRESSING
PRESSURE DRESSING
OCCLUSIVE DRESSING
WET DRESSING
MUSLIN DRESSING
ROLLER GAUZE
VASELINE GAUZE
OTHER DRESSING

17

APPLICATIONS
NONE/NO MORE
TOURNIQUET
ICE/COLD PACK
HEAT PACK
DECON WIPE
IMMOBILIZE OBJECT
>OINTMENT/GEL
SALINE DRESSING
OTHER APPLICATION

18

APPLICATIONS
>NONE/NO MORE
TOURNIQUET
ICE/COLD PACK
HEAT PACK
DECON WIPE
IMMOBILIZE OBJECT
OINTMENT/GEL
SALINE DRESSING
OTHER APPLICATION

Continue to next page ->

Continue

19
GENERAL PROCEDURES
NONE/NO MORE
ASSIST VENTILATION
CRICOTHYROIDOTOMY
NEEDLE THORACENT
CPR
ON AFFECTED SIDE
>CLEAN/FLUSH WOUND
C-SPINE/BOARD
INDUCED VOMITING
SALVAGED BODY PART

20
GENERAL PROCEDURES
>NONE/NO MORE
ASSIST VENTILATION
CRICOTHYROIDOTOMY
NEEDLE THORACENT
CPR
ON AFFECTED SIDE
CLEAN/FLUSH WOUND
C-SPINE/BOARD
INDUCED VOMITING
SALVAGED BODY PART

21
ACTION TAKEN
RETURNED TO DUTY
AMBULATORY EVAC
>MEDEVAC
EXPIRED

22
MEDICAL PROVIDER
>CORPSMAN/MEDIC
SELF-AID
BUDDY-AID
DOCTOR
NURSE
OTHER MED PROVIDER

23
MAIN MENU
>ASSESSMENT
TREATMENT
PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

24
ASSESSMENT
WOUND
ENVIRONMENTAL
DISEASE/INFECTION
>BURN
INTERNAL
BEHAVIORAL/PSYCH
MISC PROBLEMS
UNKNOWN PROBLEM
EXIT

25
BURN TYPE
>THERMAL BURN
CHEMICAL BURN
LIQUID BURN
ELECTRICAL STEAM
STEAM BURN
HOT METAL BURN
DIRECTED ENERGY
OTHER TYPE BURN
EXIT

26
BODY SURFACE AREA
>1-10% BURNED
21-30% BURNED
31-40% BURNED
41-50% BURNED
51-60% BURNED
61-70% BURNED
71-80% BURNED
81-90% BURNED
91-100% BURNED

27
BURN DEGREE
1ST-SUPERFICIAL
2ND- PARTIAL THICK
>3RD-FULL THICKNESS
UNK BURN DEGREE

28
DISTAL PULSE?

PRESS 'NO' OR **'YES'**

29
LOCATION
NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
>UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

30
UPPER TORSO
SHOULDER
>CHEST
UPPER BACK
UPPER SPINE
RIBS
ABDOMEN
EXIT

31
SUCKING WOUND?

PRESS **'NO'** OR 'YES'

32
WHICH AREA?

NO MORE
RIGHT
LEFT
BACK
FRONT
TOP
>CENTER
BOTTOM

33
WHICH AREA?

>NO MORE
RIGHT
LEFT
BACK
FRONT
TOP
CENTER
BOTTOM

34
LOCATION
>NO MORE LOCATIONS
GENERAL LOCATION
HEAD/NECK
FACE
UPPER TORSO
LOWER TORSO
ARM/HAND
LEG/FOOT

35
MAIN MENU
ASSESSMENT
TREATMENT
>PATIENT CONDITION
DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

36
PATIENT CONDITIONS
>VITALS
BLOOD LOSS
CHEST CONDITIONS
LUNG SOUNDS
CONSCIOUSNESS
SKIN CONDITIONS
EYE CONDITIONS
SYMPTOMS
GLASGOW
EXIT

Continue to next page ->

37

PULSE RATE
UNKNOWN
NO PULSE
1-19/MIN PULSE
20-39/MIN PULSE
40-59/MIN PULSE
>60-79/MIN PULSE
80-99/MIN PULSE
100+/MIN PULSE

38

IS PULSE RHYTHM REGULAR?

PRESS 'NO' OR **'YES'**

39

PULSE STRENGTH
UNKNOWN
NO PULSE
WEAK PULSE
>MODERATE PULSE
STRONG PULSE

40

RESPIRATION
UNKNOWN
NO RESPIRATION
1-5/MIN RESP
>6-9/MIN RESP
10-19/MIN RESP
20-29/MIN RESP
30+/MIN RESP

41

RESPIRATION QUALITY
UNKNOWN
ABSENT RESP
NORMAL RESP
>SHALLOW RESP
LABORED RESP
DISTRESSED RESP
IRREGULAR RESP

42

TEMPERATURE
>UNKNOWN
SIG BELOW NORM
JUST BELOW NORM
NORMAL TEMP
JUST ABOVE NORM
SIG ABOVE NORM

43

SYSTOLIC BP
UNKNOWN
NO SBP
1-49 SBP
50-75 SBP
>76-89 SBP
90-109 SBP
110-129 SBP
130-149 SBP
150+ SBP

44

DIASTOLIC BP
>UNKNOWN
NO DBP
1-19 DBP
20-39 DBP
40-59 DBP
60-79 DBP
80-99 DBP
100-119 DBP
120+ DBP

45

CAPILLARY REFILL
UNKNOWN
NORMAL CAP REFILL
>DELAYED CAP REFILL
NO CAP REFILL

46

MAIN MENU
ASSESSMENT
TREATMENT
PATIENT CONDITION
>DISPOSITION
DISPLAY PATIENT ID
DISPLAY MED-ALERT
DISPLAY MED DATA
FMDS

47

DISPOSITION
ACTION TAKEN
MEDICAL PROVIDER
RELIGIOUS SERVICE
>ORDERS

48

ORDERS
NONE/NO MORE
ORD ASPIRIN
ORD ATROPINE
ORD 2 PAM CHLORIDE
ORD MORPHINE
ORD DIAZEPAM
ORD IV
ORD ANTIBIOTICS
>ORD MISC MEDS

49

ORD MISC MEDICATIONS
ORD PREVENTIVE MED
ORD ANTISEPTIC
>ORD SEDATIVES
ORD TETANUS
ORD IBUPROFEN
ORD ANALGESIC
ORD ANTIHISTAMINE
ORD STEROIDS
ORD OTHER MED
EXIT

50

HOW OFTEN
>AS NEEDED
EVERY HOUR
EVERY 3-4
EVERY 4-8
EVERY 8-12
EVERY 12-24
ONCE A DAY
EVERY OTHER DAY
ONCE A WEEK

51

ORDERS
>NONE/NO MORE
ORD ASPIRIN
ORD ATROPINE
ORD 2 PAM CHLORIDE
ORD MORPHINE
ORD DIAZEPAM
ORD IV
ORD ANTIBIOTICS
ORD MISC MEDS

END: Please exit the program.

Appendix B
Testing and Training Booklet

Evaluation of Methods for Documenting Battlefield Medical Care

The Naval Health Research Center is conducting this project to evaluate three data entry methods for documenting casualty care. The data and information you provide us will serve several purposes: 1) it will tell us which data entry method is the most appropriate for documenting medical care, 2) it will provide feedback regarding areas of decision support and biosensors that should be pursue, and 3) it will ultimately benefit the corpsmen in the field who will be the end users.

Your individual data and responses will be kept strictly confidential. Your data will be combined with that of others so that it will be impossible to identify individual responses.

Thank you for your time and participation. If you have any questions regarding the MEDTAG testing or survey call Dr. Paula Konoske (619) 553-0730.

PRIVACY ACT STATEMENT

1. Authority. 5 U.S.C. 301
2. Purpose. Medical research information will be collected in an experimental research project entitled, "Augmentation of the Hand-held Field Documentation Device," to enhance basic medical knowledge, or to develop tests, procedures, and equipment to improve the diagnosis, treatment, or prevention of illness, injury, or performance impairment.
3. Routine Uses. Medical research information will be used for analysis and reports by the Departments of the Navy and Defense, and other U.S. Government agencies. Use of the information may be granted to non-Government agencies or individuals by the Navy Surgeon General following the provisions of the Freedom of Information Act or contracts and agreements. I voluntarily agree to its disclosure to agencies or individuals identified above, and I have been informed that failure to agree to this disclosure may make the research less useful. The "Blanket Routine Uses" that appear at the beginning of the Department of the Navy's compilation of medical databases also apply to this system.
4. Voluntary Disclosure. Provision of information is voluntary. Failure to provide the requested information may result in failure to be accepted as a research volunteer in an experiment, or in removal from the program.

Background

In response to deficiencies in the Field Medical Card (DD Form 1380), the Navy has developed a portable, electronic data-collection device called the MEDTAG. It is designed as a small handheld computer with a two-button method of entering data. Data are written to an individual's MARCard which is like a dogtag with memory that can store a person's identification information as well as his/her medical record. Currently, the Naval Health Research Center is investigating possible enhancements to the MEDTAG. The study you are helping us with is designed to compare three different methods of data input, including the new technology of speech recognition. We are also looking into decision support and biosensor possibilities. Your help with this project may allow us to improve the MEDTAG. Such improvements might ultimately benefit the corpsmen in the field by providing a fast, accurate and thorough method of documenting battlefield casualties.

Training Instructions

You will be given two medical scenarios to document using three different input methods; keyboard, two-button, and speech recognition. You will use each input device to navigate through the MEDTAG menus and select the appropriate items to write to the MARCard. The items you will be entering will be given to you in advance. We will walk you through the practice trials twice. This will take approximately 15 minutes. You will then perform the test trial which will be timed and recorded.

Keyboard Data Entry Method

To navigate the MEDTAG menus, use the “Y” and “N” keys on the keyboard. Every time the “N” key is pressed, you will hear a low tone. Every time the “Y” key is pressed, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message “ACCESSING CARD” at the bottom of the MEDTAG when this is happening. A tone will sound when you can resume entering data. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Two-button Data Entry Method

To navigate the MEDTAG using the two-button model, use the "Yes" (right) and "No" (left) buttons for "yes" or "no" responses. To move down a menu, press the "No" button and to select an item press the "Yes" button. Please use one hand. Allow about half a second for the button press to register each item. Every time a "No" button press is recognized, you will hear a low tone. Every time a "Yes" button press is recognized, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message "ACCESSING CARD" at the bottom of the MEDTAG when this is happening. A high tone will sound when you can resume entering data. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Speech Data Entry Method

To navigate the MEDTAG menus using the speech recognition system, say “Yes” or “No.” To move down the menus, say “No.” To select an item, say “Yes.” Please allow about half a second for each word to be recognized. Speak clearly. If the system does not recognize what you say, repeat the word. Every time a “No” or “Next” utterance is recognized, you will hear a low tone. Every time a “Yes” or “Select” utterance is recognized, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message “ACCESSING CARD” at the bottom of the MEDTAG when this is happening. A tone will sound when you can resume entering data. Make sure the microphone is approximately 1/2 inch from your mouth during all training and testing trials. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. During this part, if you need to talk outside the context of the program, please press the spacebar to turn off the microphone. Press the spacebar again to turn the microphone back on and resume data entry.

Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Testing Instructions

Now let's begin the test trials which will be timed and recorded. You will be given two medical scenarios to document using three different input methods; keyboard, two-button, and speech recognition. You will use each input device to navigate through the MEDTAG menus and select the appropriate items to write to the MARCard.

Keyboard Data Entry Method

Remember, to navigate the MEDTAG menus, use the “Y” and “N” keys on the keyboard. To move down the menus, use the “N” key and to select an item, use the “Y” key. Every time the “N” key is pressed, you will hear a low tone. Every time the “Y” key is pressed, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message “ACCESSING CARD” at the bottom of the MEDTAG when this is happening. A tone will sound when you can resume entering data. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Two-button Data Entry Method

Remember, to navigate the MEDTAG using the two-button model, use the "Yes" (right) and "No" (left) buttons for "yes" or "no" responses. To move down a menu, press the "No" button and to select an item press the "Yes" button. Please use one hand. Allow about half a second for the button press to register each item. Every time a "No" button press is recognized, you will hear a low tone. Every time a "Yes" button press is recognized, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message "ACCESSING CARD" at the bottom of the MEDTAG when this is happening. A high tone will sound when you can resume entering data. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Speech Data Entry Method

Remember, to navigate the MEDTAG menus using the speech recognition system, say "Yes" or "No" for "yes" or "no" responses. To move down the menus, say "Next." To select an item, say "Select." Please allow about half a second for each word to be recognized. Speak clearly. If the system does not recognize what you say, repeat the word. Every time a "No" or "Next" utterance is recognized, you will hear a low tone. Every time a "Yes" or "Select" utterance is recognized, you will hear a medium tone. Please wait while data are written to and read from the MARCard. You will be able to see the message "ACCESSING CARD" at the bottom of the MEDTAG when this is happening. A tone will sound when you can resume entering data. Make sure the microphone is approximately 1/2 inch from your mouth during all training and testing trials. Please perform the tasks quickly, but do not rush so much that you make errors. If you do enter an incorrect item please enter the correct item after it. During this part, if you need to talk outside the context of the program, please press the spacebar to turn off the microphone. Press the spacebar again to turn the microphone back on and resume data entry. Do you have any questions?

Now, go to the first casualty scenario and begin. Remember, first insert the MARCard in the card reader that is located next to the computer.

Appendix C

Demographics

1. Name: ______________________________ 2. Rate/Rank: ____________

3. Date of birth: Month ___ Day ___ 19__ __ 4. SSN: __ __ __-__ __-__ __ __ __

5. What is your highest level of education completed?

_____a. Less than high school _____c. High School _____e. 2-yr. college (AA)
_____b. GED _____d. Some college (No degree) _____f. 4-yr. college (BA/BS)

6. Have you graduated from corpsman school?____ Yes ____ No 7. If Yes, when? Month____________, 19__ __

8. Have you had field experience with the DD Form 1380 (Field Medical Card)? ___Yes___No

9. Have you ever been deployed? ___ Yes ____ No

10. If Yes, when and where was your deployment? Where______________Date________

11. Are you fluent in English? ___Yes ___No

12. Which is your dominant hand? ___Left ___Right ___Both

13. What is your computer experience? ___None ___Some ___Daily

14. Check any of the following you are experiencing today:

___a. Hearing impairment/Loss ___c. Weakness/Injury to finger(s)/hand(s)
___b. Speech impairment/Stressed voice ___d. Repetitive stress injury/Carpal tunnel syndrome

15. Do you wear corrective lenses for your eyesight?___Yes ___No 16. If yes, are you wearing them now?___Yes ___No

17. What time did you get up this morning? _______(Military time) 18. How many hours sleep did you get last night? ______ Hours

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13. ABSTRACT *(Maximum 200 words)*

During combat, documentation of medical treatment information is critical for maintaining continuity of patient care. Knowledge of the prior status and treatment of patients, however, is limited to the information noted on the paper Field Medical Card (FMC). Recently, interest in voice data entry methods has been shown for use in an environment where the corpsman's eyes and hands are busy delivering medical care. This study evaluated the speed and accuracy of three data entry methods (keyboard, two-button, and voice) for documenting injury and treatment data for two hypothetical patients. Perceptions of the corpsmen regarding the ease of learning and using these input methods were also gathered. In general, the speech recognition method was found to be slower, yet somewhat more accurate, than either the keyboard or the two-button method. Further, users reported a preference for the two-button method. The novelty of the speech recognition system could account for these findings. Viewed in this light, voice holds much promise as a mode of input for medical documentation. Future work will focus on expanding the vocabulary available to the users, thus making the interaction more consistent with the way they actually perform their jobs.

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